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ABSTRACT

The purpose of this study was to examine the effectiveness of computer-animated dissection techniques versus the effectiveness of traditional dissection techniques as related to student achievement. The sample used was 104 general biology students from a small, rural high school in Northeast Tennessee. Random selection was used to separate the students into an experimental group and a control group. The control group dissected a preserved earthworm. The experimental group dissected the earthworm using a CD-ROM dissection tool. Each student then took a test over the earthworm. This exact procedure was then used with the dissection of frog. Data were analyzed using a t-Test for Independent Means. Results indicated that there was a significant difference between the academic achievement of students in the control group versus students in the experimental group. The academic achievement of males in the control group versus males in the experimental group and females in the control group versus females in the experimental group was also examined. The data were analyzed using a t-Test for Independent Means. The results indicated that there was no significant difference in the academic achievement of the two groups. Further research is needed in this area. (Contains 22 references.) (Author/DDR)

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Running head: TRADITIONAL VS. COMPUTER ANIMATED DISSECTION

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The Effects of Computer Animated Dissection Versus Preserved Animal Dissection on the Student Achievement in a High School Biology Class

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Abstract

The purpose of this study was to examine the effectiveness of computer-animated dissection techniques versus the effectiveness of traditional dissection techniques as related to student achievement. The sample used was 104 general biology students from a small, rural high school in Northeast Tennessee. Random selection was used to separate the students into an experimental group and a control group. The control group dissected a preserved earthworm. The experimental group dissected the earthworm using a CD-Rom dissection tool. Each student then took a test over the earthworm. This exact procedure was then used with the dissection of the frog. Data were analyzed using a T-Test for Independent Means. Results indicated that there was a significant difference between the academic achievement of students in the control group versus students in the experimental group. The academic achievement of males in the control group versus males in the experimental group and females in the control group versus females in the experimental group was also examined. The data were analyzed using a T-Test for Independent Means. The results indicated that there was no significant difference in the academic achievement of the two groups. Further research is needed in this area.

Review of Literature

For years high school biology has been taught in much the same way. Ask most people about their own high school biology class and they will have very similar memories. Even if they do not remember the teacher, the other students, or much of the material, they will remember the dissecting. The dissection of preserved specimens has been part of the biology curriculum since the early 1900's (Kinzie, 1993). The question arises however, do science teachers continue to include the dissection of invertebrates, vertebrates and amphibians because it is the best method of presenting the anatomy of these animals, or do science teachers continue to dissect because it is the way it has always been done? (Haury, 1996)

Resistance to the use of animals for dissection has continued to grow since the mid to late 80's. There were, and still are, many arguments against the dissection of animals in the high school biology classroom. Some of the strongest objections have come from those who disagree with the morality of using animals. Many researchers argue that science educators cannot instill an appreciation for life if they continually take life in the name of science (Strauss, 1994; National Association of Biology Teachers, 1990; Russell, 1980).

A second argument comes from those who believe that dissection infringes upon the students' rights. Many researchers feel that students are not properly informed of their rights to refuse to dissect. They also fear that there [illegible]t an equivalent assignment for those who choose not to dissect. Both California and Florida have passed legislature protecting the rights of those students who do not want to dissect (Balcombe, 1997; Orlans, 1988).

The most recent argument against dissection in the classroom comes from those who believe that computer animated dissection is just as effective as traditional dissection. Software companies are currently bombarding teachers with new and improved programs for classroom use. Proponents of computer-animated dissection often stress the economical benefit of buying software one time versus buying of preserved specimens year after year. Teachers are also enticed by the idea of a quick and clean solution to exam and lab make-ups (Anzovin, 1993).

With all the information that is out there about dissection, it is hard for a science educator to know what to do. For years, traditional dissection has been used and has been effective. However, education must change with the times. Is computer-animated dissection an effective means for teaching the anatomical structures of animals? Science educators must make their decision based upon what is the most beneficial for the learning process of their students.

Traditional Dissection

There are several goals in the high school biology curriculum. Two of the main goals are to understand the process of scientific inquiry and to foster a reverence for life. Proponents of dissection argue that both curriculum objectives can be taught and assessed by the use of dissection. The key to success is the use of carefully planned and monitored dissection activities. Allowing students to use scientific inquiry to explore the internal structures of different organisms creates an appreciation for the uniqueness of life. The teachers can then use that newfound appreciation to stress the importance of preserving and respecting such life forms (Berman, 1984; Igelsrud, 1987).

Another reason some educators continue to use traditional dissection in the classroom is the lack of information available in the literature about the effectiveness of computer-based alternatives (Haury, 1996). Many teachers are not ready to discontinue the use of what they consider to be an effective tool, and research supports this idea. The use of traditional dissection results in greater student learning when compared with non-dissection alternatives. In 1999, Marszalek & Lockard studied a population of 354 seventh-grade students in fourteen classes in a suburban school district. The students were divided into three treatment groups: a desktop microworld group, an interactive tutorial group, and a conventional frog dissection group. Marszalek & Lockard found that the use of conventional dissection resulted in a greater immediate gain of knowledge. It was also determined that students using traditional dissection techniques actually showed lower science anxiety than students who used a CD tutorial or a desktop microworld program. As a result, many educators feel that more and better simulations need to be developed before they move away from the use of traditional dissection. Some educators still assert that there is simply no substitute for dissection (Thomas & Hooper, 1991; Offner, 1993).

Students' Attitudes Toward Dissection

Often, the effectiveness of an educational tool is measured by looking at student achievement. However, there are other factors that also need to be taken into consideration when monitoring effectiveness. A student's attitude toward dissection is a factor that needs to be considered. Most students dissect, when asked to, without dispute. However, The Humane Society of the United States published several studies that

showed many students have serious reservations about the dissection of animals (Adkins & Lock 1994; Bennett, 1994). Most teachers, however, report only a three to five percent objection rate. This discrepancy is attributed to the fact that a large majority of students never openly object to dissection. This is in part because their school environment does not foster an atmosphere in which objection would be acceptable. Another reason for such discrepancies is that most students and parents are not given proper notification and education on the topic of dissection-choice laws (Balcombe, 1998).

Other researchers have also studied students' attitudes toward dissection. In 1988, Alan Bowd conducted a study in which he found that out of a random sample of 191 undergraduate students surveyed about their high school experience with dissection, 30% reported an either positive or neutral emotional response to dissection. On the other hand, 27% of the students reported a negative emotional response toward the dissection process, and another 38% reported both negative and positive emotions. Bowd concluded therefore, more than half of the students in that study experienced negative feelings.

In 1986, 211 college students and 39 life science professionals were surveyed. Out of those polled only 35% felt that students enjoyed dissection. Ironically, 67% felt that dissection was an effective tool and that much could be learned through dissection (Sieber, 1986).

A similar study was conducted in 1992. Out of 468 fourteen and fifteen-year-old students, 73% felt that it was wrong to breed animals for dissection. Out of that same

sample, 84% wanted an alternative to dissection and 38% would object completely to the dissection of any animal (Millet & Lock, 1992).

Proponents of dissection, however, look to the findings of a 1994 study conducted by Strauss and Kinzie. The sample came from two high school biology classes. The results from their research showed students who dissect feel more positive about dissection after the experience. Over time the students actually valued the use of animal dissection more and more, whereas the students who used simulation techniques retained very negative feelings toward traditional dissection.

Computer-Animated Dissection

There have been studies conducted on the effectiveness of these high-tech and low-tech alternatives. Jonathon Balcombe (1998), in conjunction with The Humane Society of the United States, has compiled a collection of 12 studies which concluded that students using alternative materials (CD-ROMs, models, etc.) performed at least as well as students who used traditional dissection.

Many studies have been conducted on the effectiveness of computer-animated dissection techniques versus traditional dissection at all levels of education. Several research studies have focused on secondary schools (Zirkel & Zirkel, 1997), the first of which occurred in 1968. Fowler & Brosius compared the use of a filmstrip with the actual dissection of a frog when teaching tenth-graders. They measured student achievement and student attitudes using a sample of 150 students. According to their findings, the filmstrip group outscored the conventional dissection group. Unfortunately, Fowler & Brosius did not use inferential analysis on their descriptive results and

therefore failed to disprove their findings were not due to chance alone (Zirkel & Zirkel, 1997). Another study compared students who learned via lecture versus students who actually dissected. The results showed that the lecture group scored higher but there was no difference when attitude was tested (McCollum, 1988).

In a similar study, Kinzie & Strauss (1994) conducted an experiment in which they compared the use of traditional dissection with the use of the Interactive Frog Dissection. For this experiment, the population was two high school biology classes. Using random selection, one group used traditional frog dissection while the other group used the Interactive Frog Dissection. They concluded that there was no significant difference in achievement scores between the two groups.

Conclusion

The current research reviewed on traditional dissection versus computer-animated dissection was relatively consistent (Zirkel & Zirkel, 1997). Most studies concluded that there appeared to be no significant difference in the students' achievements, but there was a difference in the students' attitudes toward dissection. Students who used traditional dissection were less likely to disapprove of dissection than those students who used an alternative to dissection (Kinzie, Strauss & Foss, 1993; Kinzie & Strauss, 1994). Research also supported that many computer-animated alternatives work well as introductions or supplements to an actual dissection (Marszalek & James, 1999). However, all of the studies concluded with recommendations for further research to be done. The findings must be sustained by further research in order to know if dissection alternatives have any significant educational value (Kinzie & Strauss, 1991).

Methodology and Procedure

The population of the study was taken from a small, rural high school in Northeast Tennessee. The town in which the high school is located had a population of approximately 11,931 with thirty-nine percent of residences having school-age children. The high school consisted of approximately eight hundred students ranging from ninth through twelfth grade. Of those eight hundred students, one hundred and forty-four were part of the Free Lunch Program. Thirty-seven students received lunches that were reduced in price. The population of the high school was ninety-five percent Caucasian, three percent African-American, and slightly more than one percent Asian and Hispanic. The racial background of the surrounding community was very similar with ninety-five percent Caucasian, three percent African-American, one percent Asian and Hispanic, and less than one percent other. Sixty-one percent of those who lived in the surrounding community graduated from high school and thirteen percent had received a bachelor's degree or higher.

The sample used in the study was 104 general biology students. The students were all assigned to the same teacher and were spread over four classes. All four biology classes were heterogeneously assigned according to student ability. Out of the 104 total students, 53 were male and 51 were female. There were 74 freshmen, 23 sophomores, 6 juniors, and 1 senior in the sample. Regarding ethnic diversity, 3 of the 104 students were African-American, 1 student was Hispanic, and the rest were Caucasian. Random assignment was used to separate the students into two groups, the experimental group and

the control group. The experimental group had 50 students, 26 males and 24 females. The control group had 54 students, 27 males and 27 females.

There were two teacher-designed assessment tools used in the study. These assessment tools consisted of two tests adopted from a general biology test bank. The first section of each test consisted of multiple-choice questions. On the second page of the tests, students were given a word bank and asked to identify parts of the earthworm's or frog's internal and external anatomy using an actual earthworm or frog specimen. The structures were marked by flags, which had numbers on them that corresponded to the appropriate answer blanks on the tests. On the last page of the tests students were asked to label drawings of the internal and external features of the earthworm or frog. Both tests were given two days after the dissection of the earthworm or the frog, with only a day of review separating the dissection and the test.

Procedures

The researcher sought permission from the school principal and administration before the study was conducted. After permission was granted, the study began with 104 general biology students. The students were randomly assigned to the experimental and control groups. The experimental group had 50 students and the control group had 54 students. All of the students were given information about the earthworm by the researcher, using the same methods of instruction. The students defined pertinent vocabulary, took notes from an overhead projector, and watched a video dissection of an earthworm. On lab day, both groups were given a laboratory guide that included general questions about the earthworm's internal and external anatomy. The only difference being, the laboratory guide given to the experimental group included questions, as well as

a thorough explanation of how to use the CD-ROM. The control group stayed in the classroom, worked in groups of two, and dissected a preserved earthworm. The experimental group went to the school's computer lab, under the researcher's supervision, and worked in groups of two. The experimental group then dissected an earthworm using a CD-ROM dissection tool, *DissectionWorks*. On the day following the lab, all students reviewed together in preparation for the test. On the second day after the dissection, students completed a test over the earthworm. This exact procedure was also used with the dissection of the frog. Data for analysis were collected using two teacher-made tests covering the function and structure of the anatomical features of the earthworm and the frog. The first section of each test consisted of multiple-choice questions, which were taken from the test bank that accompanies the biology textbook. On the second page of the tests, students were given a word bank and asked to identify parts of the earthworm's or frog's internal and external anatomy using an actual earthworm or frog specimen. The structures were marked by flags, which had numbers on them that corresponded to the appropriate answer blanks on the tests. On the last page of the tests students were asked to label drawings of the internal and external features of the earthworm or frog. Both tests were given two days after the dissection of the earthworm or the frog, with only a day of review separating the dissection and the test.

Results

Three research questions were used to guide the analysis of the data. Each research question was followed by a research hypothesis. Research questions 1, 2 and 3 were analyzed by using t-test for independent means. All data were analyzed using a .05 level of significance.

Research Questions

1. Is there a difference in student achievement between students who use CD-ROM dissection tools and students who use preserved animal specimens?
2. Is there a difference in the academic achievement of the females in the control group versus females in the experimental group?
3. Is there a difference in academic achievement of the males in the control group versus males in the experimental group?

The results of independent t-test for question 1 indicated a significant difference (t= 2.026, df 102). Therefore, the null hypothesis was rejected. T-test for independent means for research questions 2 and 3 were not significant (t= 1.04, df 46; t= 1.84, df 51 respectively). The results for students using CD-ROM and those using preserved animals is displayed in Table 1.

Table 1

T-test for Independent Means for Control and Experimental Group

Group	(M)	df	SD	t-value	Sig. (two-tailed)
Experimental	71.28	102	13.13	2.026	.04*
Control	76.49		13.07		

Note. *p < .05.

Discussion

When research question 1 was examined, is there a difference in student achievement between students who use a CD-Rom dissection tool and students who use a preserved animal specimen, a T-Test for Independent Means was conducted. The results of the study indicated that there was a significant difference between the control group and the experimental group ($t = 2.026$, df 102, $p < .05$). Therefore, the null hypothesis was rejected.

The data analysis indicated that students who used a preserved animal specimen scored higher on related chapter tests than students who used a CD-Rom dissection tool. There were several reasons for the significant difference between the mean scores. First, as stated in the literature review, the use of conventional dissection techniques results in a greater immediate gain of knowledge (Marszalek & Lockard, 1999). When students participate in an authentic learning task, such as dissection, there is a greater retention of knowledge.

The results of this study were contrary to much of the available research on this topic. The majority of the research used in the literature review indicated that there was no significant difference between the academic achievement of the students who use preserved animals and those who use interactive video for dissection (Kinzie, Foss, & Powers (1993); Kinzie & Strauss (1994)). However, in this study the control group, after dissecting a preserved animal specimen, found it easier to identify the anatomical structures of that animal on the test. Students who used an authentic method of dissection, retained more knowledge of the anatomical structures of the earthworm and the frog and thus received higher scores on the related tests. This research study

therefore indicated that the authentic task of dissection increased the retention of knowledge to a greater degree than the virtual experience of the CD-Rom dissection.

In regard to research questions 2, is there a difference in the academic achievement of females in the control group versus females in the experimental group, and in regard to research question 3, is there a difference in the academic achievement of males in the control group versus males in the experimental group, a T-Test for Independent Means was conducted. The results indicated that for both research question 2 and 3 there was no significant difference between the control group and the experimental group ($t = 1.04$, df 46, $p > .05$; $t = 1.84$, df 51, $p > .05$) respectively.

Although the research indicated that there was a significant difference between the academic achievement of the control group versus the experimental group, with regard to gender, there was no significant difference. The research indicated that when studied individually, the females in the control group did not score significantly higher than the females in the experimental group. Also, the males in the control group did not score significantly higher than the males in the experimental group. However, when the mean scores for females in the control group were compared to the mean scores for the females in the experimental group, the results indicated that the mean score for the control group was higher than the mean score for the experimental (control $M = 73.61$, experimental $M = 69.98$) although not significant. Consequently, the mean score for the males in the control group was higher than the mean score for males in the experimental group (control $M = 79.37$, experimental $M = 72.48$) although not significant. Therefore, this superior performance of the males and females in the control group could account for

the significant difference in performance when the control group and experimental group were used as a unit of analysis.

Conclusions

This research was conducted to examine the effectiveness of computer-animated dissection techniques versus the effectiveness of traditional dissection techniques as related to student achievement in the high school biology classroom. The results of this study indicated that there was a significant difference in the academic achievement of students who used traditional dissection techniques versus students who used computer-animated techniques.

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